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"Personnel Management Techniques Necessary to Maximize Bio-Barrier Integrity at a Martian Receiving Laboratory"

also identified as

"Safety of Containment Systems"

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Planning for control against back contamination associated with a Mars Surface Sample Return Mission (MSSR) might proceed from any of several bases -- conceptual models and experience with the Lunar Receiving Laboratory represent two such bases. Reports concerning the LRL suggest that the provisions guarding against back contamination were not as successful as desired and ought to be improved for a MSSR mission. These reports also suggest that discrepancies in the performance of back contamination provisions can be attributed largely to discrepancies in the performance of people rather than to discrepancies in technology. Such a suggestion is not unnatural given the highly advanced technology associated with all operations of NASA.

The performance of people in an organization is not independent of other organizational influences such as demands of technology, organizational relationships, communications channels and the like. Any organization (including LRL) is a multivariate system, and it is difficult to attribute performance to any single variable in the system. Generally speaking, we can view any organization as a complex of four different types of variables -- structure, technology, people and tasks,

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each interacting with the others (Figure I). Structure refers generally to systems of communication, authority, and work flow; technology refers to tools, both mechanical and programs; people are the actors in the system, normally human beings; and task refers to specific assignments of work, roles assigned to the actors. The behavior and performance of any organization is a function of these major variables and their interactions, probably more a function of interactions than of any single variable.

Effective performance of an organization requires appropriate balancing among the major interacting variables in the system. Any change in one variable requires an accommodating or complementary change in other variables. For example, the assignment of task variables (role or task requirements) will not accomplish a change in organizational performance if viewed by the role incumbents as unnecessary, impossible, or arbitrary. Individuals are not likely to observe safety standards in performance of their tasks if these standards are preceived as unnecessary, arbitrary, or impossible. Similarly, an apparently superior technology will not perform as designed if the actors or people in the organization find the demands of that technology to be more than they will submit; examples of people subverting a technology to perform in what thepersons believe a "better way" abound in industry. While almost all of these alterations in the application of a technology are perceived by workers as improvements, not all of them are perceived as such by designers and administrators of the technology. Finally, structure also influences organization performance, hindering or facilitating accomplishment of organizational goals. Project management and matrix organization, for example, were developed as structural approaches more appropriate to specific tasks than more traditional organization structures.

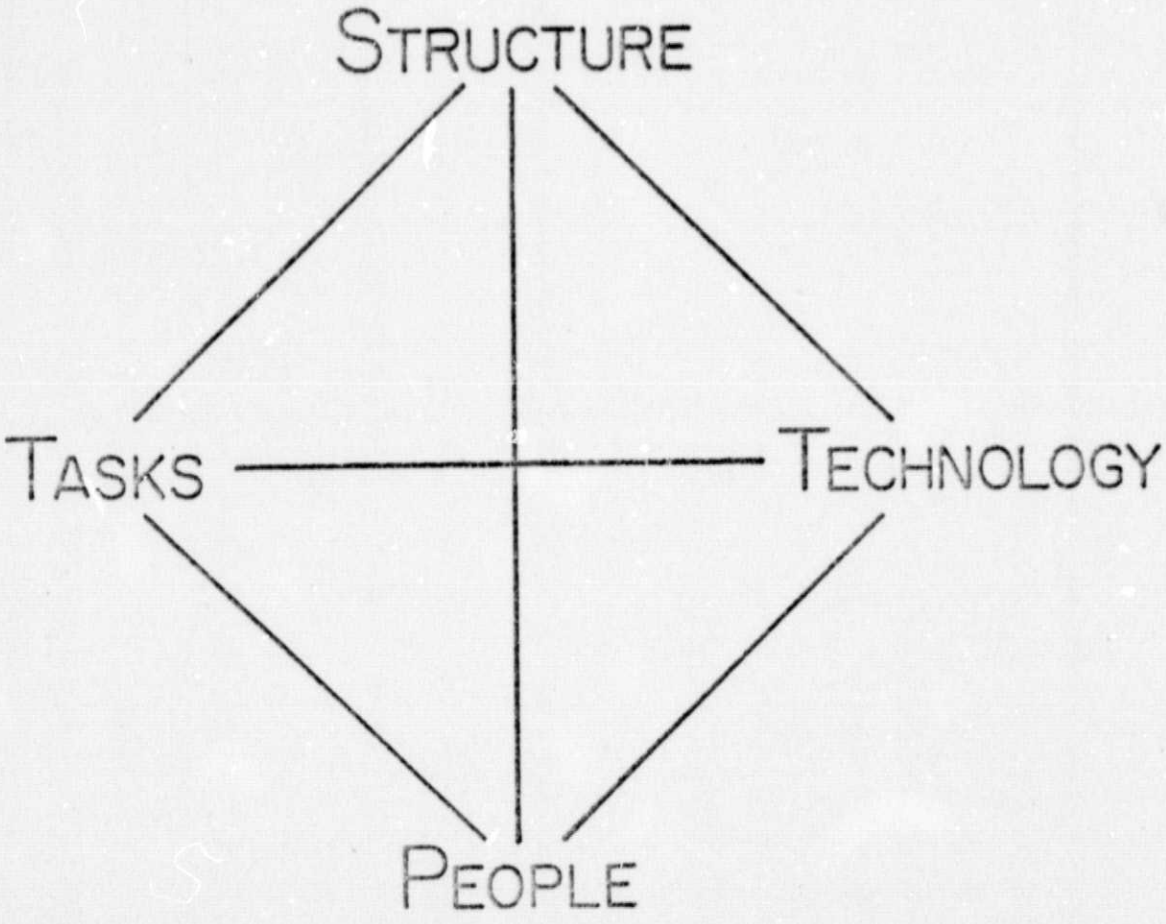

FIGURE I: Organization as a Multivariate System

People comprise a unique element in the organizational matrix. In one sense, people are the least manipulable element in the organization. While technology, structure, and task can be altered at will, people are less easily manipulated and serve as a constraint in the amount of variation permitted in other variables. In another sense, people are the most flexible and adaptive variable in the matrix. The people in an organization can make an apparently inappropriate technology perform well; they also can prevent the realization of the capabilities of an apparently outstanding technology. Outstanding people performance in an organization is still something of a mystery; we are not certain what is required for outstanding team performance. Minimum requirements appear to include cohesion among team members, clear operational goals accepted and internalized by all, and trust based upon open communications and sharing of values and influence.

The NASA organization has been credited with a number of successes in technological, administrative, and organization innovation. (See references 1-4) Yet we note that a variety of problems has been reported associated with development and performance of safeguard against back contamination from the now concluded Apollo flights. These reports of problems are surprising when viewed against the background of spectacular successes in related NASA missions. The reports of problems associated with back contamination protection also constitute a source of concern in planning for the envisioned MSSR missions. Planning for protection against back contamination from the envisioned MSSR missions ought to proceed from an analysis of what, if anything, was or will be unique about programs of quarantine and protection against back contamination for the Apollo and MSSR missions when viewed against the framework of other NASA operations.

A number of accounts have been written about NASA and its successes in the areas of technology, organization, and administration. NASA has faced a complex of diverse and dynamic environments, influences impacting on NASA operations. The diversity of environmental pressures is indicated in the range of scientific and professional interest groups, suppliers of sophisticated instrumentation, industrial and economic pressures, and governmental and political pressures exerted upon NASA activities (Figures II and III). Each of these broad environmental pressures is further differentiated as, for example, astronomers, physicists and biologists independently seek to influence NASA research. Each of these environmental forces also is dynamic over time in the sense that objectives to management and organization have replaced the more traditional "principles approach" to management and organization. Organizational experimentation within NASA and complex industrial organizations has contributed to developing knowledge of administrative and organizational contingencies. Multinational firms engaged in quite dynamic industries, for example, provide numerous illustrations of organizational experimentation to achieve integration of often quite differentiated organizational sub-units. (See references 5-11)

Several persons associated with the LRL were interviewed about their experiences, and file information was sought in an attempt to learn more about the failures in performance at LRL. The evidence obtained indicated that protection against back contamination was not viewed as a high priority goal by operational teams within the LRL. It appears as though the primary goal of NASA was a successful flight mission and that goals relating to protection against back contamination were held primarily by interested regulatory

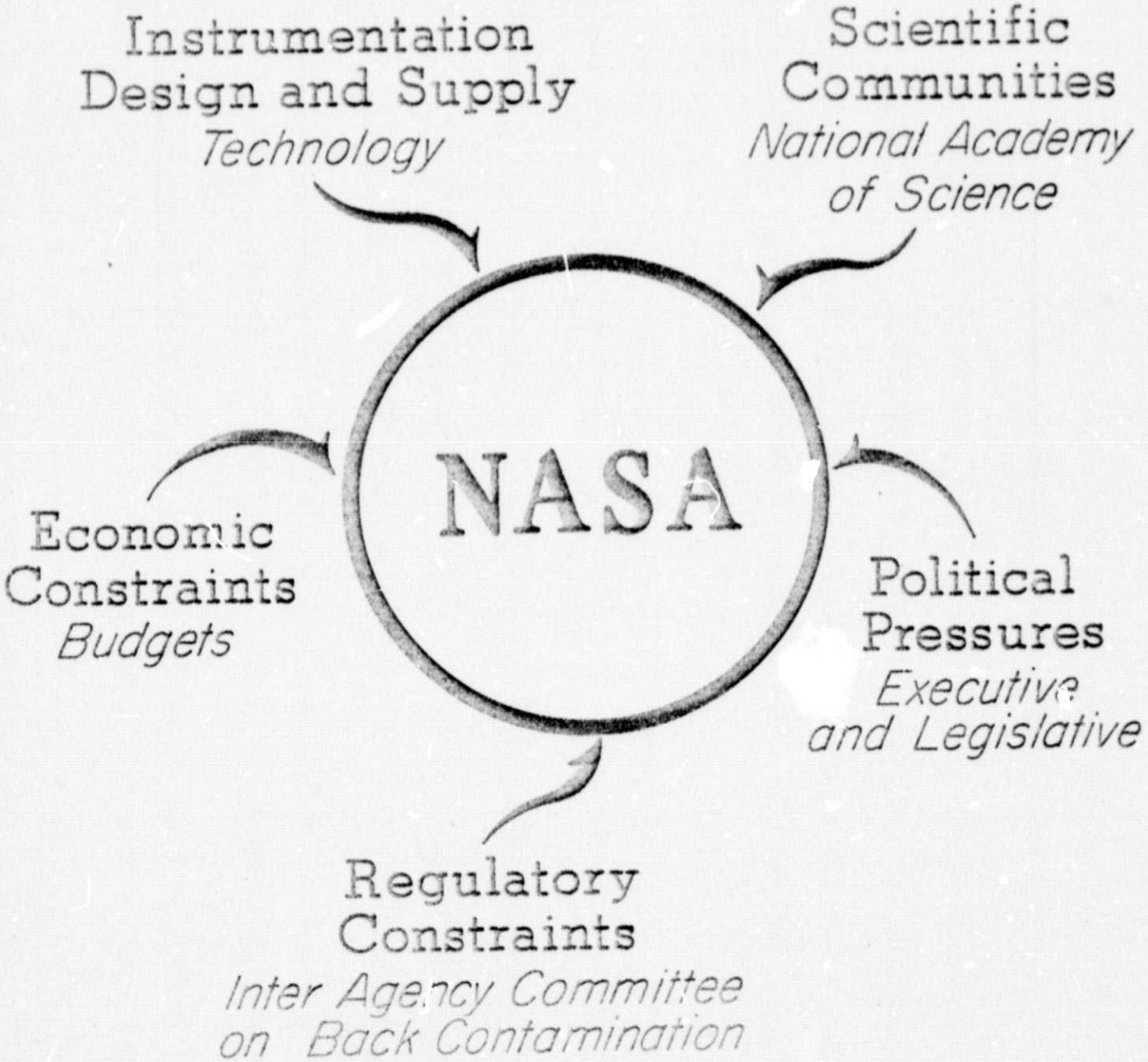

FIGURE II: Environments of NASA

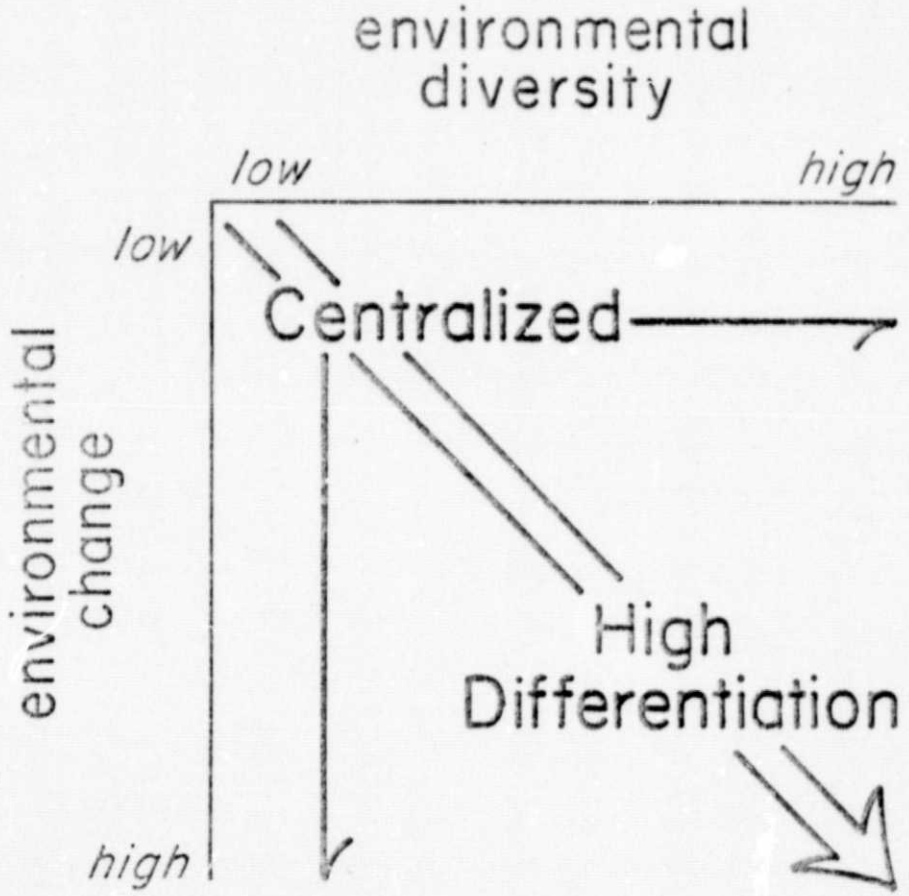

FIGURE III: Organizational Adaptation to Environment

agencies (HEW, Agriculture, Interior.) The successful performance by NASA of all responsibilities accepted as high priority goals by NASA makes it difficult to believe that successful performance of back contamination provisions would not have resulted if NASA had accepted these as goals. Rather, it appears that the differentiated responsibilities for protection against back contamination were not successfully integrated among the responsible agencies. The Inter Agency Committee on Back Contamination (ICBC) apparently was established to serve to integrate responsibilities; it apparently was dominated by NASA, however, and was not successful in the integration of responsibilities. Failure in this lack of integration of responsibilities for back contamination probably was a primary reason that individuals performing tasks in the LRL were less concerned with quarantine measures than they might have been.

Several illustrations can be cited of the inability of the ICBC to serve as an adequate integrating mechanism for the LRL activities; these illustrations also point up the type of problem to be anticipated in planning for the MSSR missions.

An often cited incident relates to the recovery of manned spacecraft in the lunar missions. ICBC quarantine programs called for lifting the manned space craft to the deck of a recovery vessel, attachment of barriers around the space craft opening, and the exit of astronauts from the space craft into a quarantine facility. Despite the development and promulgation of these procedures, it is reported that NASA claimed inability to lift the space craft to the deck of the recovery vessel at a very late stage in the mission planning, and NASA was able to obtain approval of the ICBC for exit of the astronauts without the protection of quarantine barriers. Reports also indicate that NASA

developed the ability to lift space craft from the sea relatively soon after quarantine restrictions were lifted from the lunar sample return missions. One interpretation of this reported incident is that NASA had (or could have developed) the ability to recover manned space craft from the ocean, but that it was unwilling to keep the astronauts behind quarantine barriers. This interpretation is consistent with the hypothesis that responsibilities for the lunar missions were differentiated among agencies and that NASA did not share the objectives of quarantine protections. Rather, NASA objectives concerned the return of astronauts with samples for later analysis. This incident also illustrates the ability of NASA to dominate ICBC decisions -- part-time members of the ICBC were not in a position to challenge the testimony of NASA officials nor had the ICBC a capability independent of NASA to develop capabilities to perform the recovery as originally planned. Another illustration concerns the actions of the ICBC in relationship to NASA. It has been reported that the ICBC did not communicate as a body to NASA, e.g. the ICBC did not issue directives for NASA implementation. Rather, the ICBC reacted to NASA proposals and the primary form of communication between organizations was in the form of minutes of ICBC meetings and resolutions of the ICBC. In short, the relationship between the ICBC snd NASA was poorly defined. In one sense, the ICBC ought have been an inter-agency committee of "equals" to serve as an integrating mechanism; in fact, the ICBC was established as a committee advisory to NASA and, in that sense, as an instrument of NASA.

Implementation of ICBC resolutions apparently was not entrusted to NASA line officials. Rather, individuals such as Colonel Pickering and Dr. Briggs Phillips worked in the capacity of integrating ICBC objectives with those of NASA and scientists at the operations level. The activities of these two individuals and their frustrations in the accomplishment of their responsibilities testifies to the fact that integration was not accomplished within the ICBC. One gets the impression that more integration between NASA objectives, quarantine objectives and scientific objectives was accomplished at the Pickering-Phillips level than at the ICBC level.

One illustration of Pickering - Phillips integration efforts appears in files related to the LRL project. Pickering and Phillips were hired by NASA as consultants yet held primary affiliations with non-NASA organizations. One file item is a memo directed to a NASA official detailing shortcomings in LRL development; appended to this memo is a memo of a later date directed to Dr. Sencer (PHS and ICBC) and written by a NASA official. The implication is that the original memo directed within NASA was also communicated to Dr. Sencer whose support was sought in the correction of LRL development problems. Whatever authority Pickering and Phillips possessed appears to have been a function of their non-NASA affiliations and probably was not particularly enhanced by the ICBC itself.

The clear inference drawn from our investigations is that the ICBC did not serve to integrate the objectives and responsibilites of NASA, PHS, Agriculture and Interior. We cannot at this point recommend a similar organizational framework for planned MSSR missions. Several other possibilities present themselves:

1) Responsibilities for all aspects of space exploration, including the return of samples from outer space, might be centralized in an organization such as NASA. NASA might be expected to establish differentiated subordinate organizations responsible for specific aspects of space exploration including protection against extra-terrestrial contamination. Such a subordinate organization might interface with other interested parties and pressure groups but full authority for decisions regarding protection against extra-terrestrial contamination would reside within NASA. Further, conflicts between this subordinate organization and other subordinate organizations with different responsibilities would be integrated within the NASA organization.

   This approach would require changes in existing legislation which currently provides for differentiation of responsibilities for protection against extra-terrestrial contamination. Such an approach probably would accomplish a more efficient integration of responsibilities than was accomplished in the LRL experience. This integration would in all likelihood be accomplished at the expense of the advantages associated with specialization and differentiation, however. Whether the net result would be more or less effective than the outcomes of the LRL experience is questionable.

2) Another approach would be to maintain the current differentiation of responsibilities among Federal agencies and to seek organizational vehicles for integration which would be more effective than the ICBC. Several such approaches can be suggested; others might be designed as well.

One alternative might call for the creation of an ICBC-type of organization responsible to the President for protection against extra-terrestrial contamination. This organization would be provided funds adequate to carry out its responsibilities and would not be dependent upon NASA for funding. Further, NASA would participate as a single member of the organization equal to other members and would not be allowed to dominate organizational decisison making.

Another alternative might permit each involved agency to exercise its responsibilities as appropriate, e.g. PHS and Agriculture, for example, might treat each returning mission as it would any attempted entry into the United States. This exercise of responsibilities only at time of attempted entry would be quite troublesome for NASA planning and would call forth efforts by NASA to secure advance approval of plans; however, responsibility for coordination would clearly be a responsibility of NASA. A variety of specific approaches by NASA within this general framework are possible including, for example, requesting the involved agencies to assign responsible personnel to work in combination with NASA personnel on specific projects.

It is our intent in the next year's effort to generate a range of possible organizational models which might be applied in the development and application of programs for protection against possible extra-terrestrial contamination. Lacking any method for empirical testing of these models, we will simulate tests of them using methods of conceptual analysis. In so far as possible, the implications of each proposed organization will be identified and the models compared in terms of expected outcomes.

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